BROOKHAVEN NATIONAL LABORATORY
NATIONAL SYNCHROTRON LIGHT SOURCE

MEMORANDUM

DATE: 31 October 2000

TO: Sam Krinsky, Richard Osgood, Peter Paul

CC: NSLS Management Group, FEL Project Team

FROM: William S. Graves, Richard Heese, Erik D. Johnson

SUBJECT: **DUV-FEL Project Report; Period ended 27 October 2000**

Work in Progress:

Since our last progress report, an extensive series of measurements (including initial compression studies) have been undertaken. The 'Current Beam Performance' was summarized by Bill at a meeting of the BNL Integration Council on 24 October:

	At chicane		**At Linac end**	
	Design	Measured	Design	Measured
Energy	90 MeV	82 MeV	230 MeV	200 MeV
dE/E	<.1%	<.18%	<.1%	<.07%
Bunch Length	~4ps	2.2 ps	variable	0.2 ps
Charge	0.5 nC	0.1 nC	0.5 nC	0.1 nC
Emittance	5 mm-mrad	4 - 8 mm-mrad	5 mm-mrad	4 - 8 mm-mrad
Timing Stability			<0.5 ps	0.5 - 3 ps

As it turns out our studies program was not confined to the DUV-FEL; Adnan, Timur and Li-Hua ran a series of measurements at the ATF to provide comparisons for the results of the DUV-FEL photo-injector studies thus far. Interestingly there appear to be some unanticipated differences between the systems. The ATF gun was running at higher energy (5.5 MeV) that the DUV-FEL (4.5 MeV) and even when the beam energy of the ATF gun was reduced there still remain differences in the behavior of the two photo-injectors. The voltage on the PFN at the DUV-FEL was subsequently increased so our maximum photoinjector beam energy is now 5.2 MeV. The studies program has been aimed at refining the machine and our understanding of the photo-injector performance.

The gun energy measurements are now fully debugged, and the maximum energy of 5.2 MeV has been confirmed by two different methods. The first uses a dipole trim magnet as a spectrometer, and the second compares beam offsets generated inside the solenoid with simulation. The results differ by less than 5%. Our most recent studies have continued to focus on the large beam size that is observed at the gun exit when accelerating moderate amounts of charge (> 100 pC). Possible causes include a solenoid field that is flawed, a UV laser pulse is shorter than estimated, or a field distribution in the RF gun that differs from design. The studies described below are currently underway to examine each of these possibilities.

- The solenoid field is being checked by measuring the rotation of the beam through the magnet. The important point of this measurement is that it is independent of the beam divergence properties at the magnet entrance. Preliminary results indicate that the solenoid field is unchanged from field maps taken during construction of the magnet.
- Pulse length measurements of the UV laser are difficult. The electron beam pulse length can be measured at high energy, but it is not necessarily the same as measuring the laser. Our best estimate is that the laser pulse length is near its design of 5 ps FWHM. This is based on solid autocorrelation measurements of the 800nm light that drives the tripler, and the physics of the tripling process. Errors in the pulse shape, alignment and so on would actually tend to make the pulse longer than the design, not significantly shorter. Definitive measurements will occur when our streak camera, which was specifically designed to work in the UV, is delivered in a few weeks.
- To measure the distribution of the gun fields, we are performing studies at low charge. This removes space charge effects so that the beam dynamics are dominated by the applied fields. By comparing the measured beam Twiss parameters at the gun exit with simulation we expect to determine whether the fields are balanced in the two cells, or are skewed in one direction. The field balance can be adjusted by changing the tuning screws in the full cell.

In addition to these studies we are experiencing trouble with klystron A and with the phase of the laser relative to the drive RF. Klystron A drives the gun and first two linac sections. It has been experiencing an excessive number of interlock trips caused by high current limits being exceeded. We are setting up tests to determine whether the problem is inside the tube, which would require klystron replacement, or if the PFN pulse is flawed in some way.

The phase instability between laser and RF is a new problem. Work is continuing to isolate and resolve the problem. In addition there has been some intermittent instability in the laser room temperature, which affects the laser oscillator, but we believe that this does not explain all of the drift observed. Tests are underway on the cables that connect the systems, and on the various components that could be failing.

During this reporting period we also completed the design review of the shielding systems for NISUS. The engineering and design work is proceeding well. The lead and borated polyethylene shielding components have been ordered as have a substantial share of the vacuum components required to connect the undulator to the linac.

Work Planned for Next Week(s):

It is anticipated that machine studies will continue for several weeks to resolve the beam issues. We then hope to initiate the last round of commissioning fault studies. After that the beam physics program can continue while preparations are underway for connection to the undulator. Detailed design will also continue on the FEL amplifier with the next 'exchange meeting' focusing on undulator alignment issues. A detailed long range schedule will be developed to make sure we secure the resources required to bring the FEL on line.

Management:

No new issues.